SPECIFICATION FOR STRUCTURAL STEELWORK

1.0 SCOPE OF WORK

The work covered by this section of the Specifications consists of furnishing all plants, labour, equipment, supervision, appliances and materials, and of performing all operations in connection with the fabrication and erection of Structural and Miscellaneous Iron and Steel work together with all anchors, fastenings, hardware, accessories and other supplementary parts necessary to complete the work in strict accordance with this section of the Specification and the applicable drawings and subject to the terms and conditions of the Contract.

2.0 STANDARDS

These Specifications shall be read in conjunction with the Standards in the Appendix which are deemed to form part of these Specifications. In the event of contradiction between these Specifications and Standards, the more stringent requirements shall take precedence. Reference to any standard shall include any amendment thereto.

3.0 TESTING AND INSPECTION

Whenever required, the Contractor shall satisfy the Engineer by means of numbers or identification marks on the steel, combined with a manufacturer's certificate that such steel has been tested and complies with all tests and requirements of the relevant British Standards.

Notwithstanding the conditions above, the Engineer may direct from time to time as the work proceeds that the whole or part of the steel used in the Works shall be subject to inspection and tests.

In case there is a reasonable doubt in the first trial as to the ability of this steel to meet any requirement of this specification, two additional tests shall be made on samples of steel from the same batch, and if failure occurs in either of these tests, the steel shall be rejected. The steel shall be rejected immediately if any sample fails to attain 95% of the characteristic strength.

4.0 MATERIALS

All materials used in the permanent works shall be of first class quality obtained from an approved manufacturer and shall in all respects comply with the relevant British Standards.

All ironwork, both cast and wrought, shall be free from all defects. All castings shall be perfectly true, clean and sharp and be free from air blows and sand pockets.

High tensile structural steel shall be Grade 50B to BS 4360 having minimum yield stress of 355 N/mm^2.

Mild structural steel shall be Grade 43A to BS 4360 having minimum yield stress of 275 N/mm^2.

High strength Friction Grip Bolt shall be of general grade in accordance with BS 4395.

Mild steel Black Bolts shall comply with BS 916 : 1953.

Electrodes used in welding shall comply with BS EN 499 : 1995.

5.0 GALVANIZED WORK

5.1 General

All galvanizing works where specified shall be hot-dip galvanized and shall conform to the requirements of BS 729 : 1971.

Hot-dip galvanizing is defined as a coating of zinc and zinc-iron alloy layers, obtained by dipping prepared iron or steel articles in molten zinc. Under some circumstances the whole coating may consist of zinc-iron alloy layers.

5.2 Fabrication

Care shall be taken to avoid fabrication methods which could cause distortions or embrittlement of the iron and steel articles.

Unsuitable marking paints, grease, oil and other deleterious materials shall be removed prior to fabrication of steel and iron articles.

Holes and/or lifting lugs to facilitate handling, venting and draining during the galvanizing process shall be provided at approved positions.

5.3 Surface Preparation

Materials to be galvanized shall be thoroughly cleaned of all scale, dust and dirt by pickling in a bath of muriative acid.

All welding slags and burrs, surface contaminants and coatings which cannot be removed by the normal chemical cleaning process in the galvanizing operation shall be removed by blast-cleaning with approved abrasives to Swedish Standard 2 1/2 mechanical cleaning with power operated tools or other suitable methods approved by the Engineer.

5.4 Galvanizing

Materials to be galvanized shall be handled with care so as to avoid any mechanical damage and to minimize distortion.

The materials shall be dipped in a galvanizing bath of molten zinc containing not less than 98.5% zinc at suitable galvanizing temperature and shall remain in the bath until all surfaces are evenly coated with firmly adherent spelter and the coating requirements shall comply with Sub-Clause 5.5 of these Specifications.

5.5 Coating Requirements

5.5.1 Coating Weights and Thickness

The weight and thickness of the galvanizing coating shall comply with the minimum values as shown in Table 1.

TABLE 1 - COATING WEIGHTS

Material	Minimum Average Coating On Any Individual Test Area	
	Coating Weight g/m^2	Equivalent Thickness μm
Steel 5 mm thick and over	610	85
Steel under 5 mm thick but not less than 2 mm	460	64
Steel less than 2 mm thick but not less than 1 mm	335	47
Steel articles which are centrifuged	305	42
Grey and malleable iron casting	610	85

The weight for galvanized coatings for threaded works/fasteners shall not be less than $375g/m^2$ or the equivalent thickness of the coatings shall not be less than 52 microns.

5.5.2 Surface Finish

The galvanized coating shall be continuous, adherent, as smooth and evenly distributed as possible, and free from any defect or imperfections that is detrimental to the usage of the coated article.

Where slip factors are required to enable high strength friction grip bolting, where shown, these shall be obtained after galvanizing by suitable mechanical treatment of the faying surfaces.

Where a protective coating is to be applied the galvanized materials, all spikes shall be removed and all edges shall be free from lumps and runs.

5.5.3 Adhesion

The galvanized coating shall be sufficiently adherent to withstand normal handling during transport and erection without peeling or flaking and light blows with a 0.3 kg hammer shall not cause the coating to peel adjacent to the area deformed by hammer blows.

5.6 Coating Weight

The weight of coating shall be determined by one or more methods described in BS 729 : 1971 or other methods approved by the Engineer.

Any galvanizing shown to be defective on inspection or by the hammer-blow tests will be rejected. Any work so rejected shall be rectified by the Contractor at his own expense.

5.7 Uniformity Of Coating

Copper sulphate dip test for uniformity of coating described in BS 729 : 1971 shall be followed. The coating shall withstand four one-minute dips in the standard copper sulphate solution without the formation of an adherent red spot of metallic copper upon the basis metal.

5.8 Transport and Storage

Galvanized articles, shall, wherever possible, be transported and stored under dry, well-ventilated conditions to avoid the possibility of wet storage staining.

Where required, post-treatment of galvanized products such as chromating or phosphating may be applied to reduce the risk of wet storage staining or to assist subsequent painting.

5.9 Welding

Where galvanized steel is to be welded, adequate ventilation shall be provided. If adequate ventilation is not available, supplementary air circulation shall be provided. In confined spaces a respirator shall be used.

Grinding of edges prior to welding may be permitted to reduce zinc oxide fumes formed during welding and eliminate weld porosity which may occur.

All uncoated weld areas shall be reinstated as per the Coating Reinstatement of Sub-Clause 5.9 of these Specifications.

5.10 Coating Reinstatement

Small areas that are uncoated and/or small areas of galvanized coating damaged by welding, cutting or by excessively rough treatment during transit and erection may be reinstated either by the use of low melting point zinc alloy repair rods or powders made specifically for this purpose, or by the use of at least two coats of good quality zinc-rich paint. Sufficient material should be applied to provide a zinc coating at least equal in thickness of the galvanized layer.

6.0 WORKING DRAWINGS

Two copies of all detailed working drawings prepared by or on behalf of the Contractor at his own expense shall be submitted to the Engineer for his approval, but this approval shall in no way relieve the Contractor of his responsibilities for the work under the Contract.

7.0 FABRICATION

7.1 General

The Works shall be carried in accordance with BS 449.

(i) Inspection, etc :

All workmanship shall be of first class quality in every respect, the greatest accuracy being observed to ensure that all parts will fit together properly on erection.

The Engineer shall have full liberty at all reasonable times to enter the premises of the Contractor for the purpose of inspecting work, and no work shall be taken down or packed until it has been inspected and approved. Any work found defective or which is not in accordance with the drawings or this specification shall be rejected and, if so, shall at once be made good. The Contractor shall supply free of charge all labour, tools, scaffolding, etc required in connection with the inspection of the Works.

(ii) Templates, Measurements, etc :

All templates, jigs and other appliances necessary to ensure the accuracy of the work shall be provided by the Contractor. All measurements shall be made by means of an approved steel tape.

(iii) Straightening :

Before any other work is done on them, all plates shall be checked for flatness and all bars and sections checked for straightness and freedom from twist and any corrective action shall be taken so that, when assembled, adjacent surfaces shall be in close contact throughout. The methods adopted for the above work shall be such as not to injure or mark the material.

(iv) Unless otherwise specified, steelwork may be cut by shearing, sawing or flame cutting. Surfaces produced by such cutting shall be finished square (unless a bevelled edge is called for), true and smooth to the required dimensions. Finishing of surfaces shall generally be by machining and/or grinding. In the case of flame cutting, surfaces having only slight irregularities may be lightly ground, provided that the finished edges are substantially as straight, true, smooth and regular as those produced by the finishing cut of a planing machine.

Shearing will not be permitted for main plates, reinforcing plates, main gussets and splice plates except in a direction perpendicular to the direction of their main stresses.

The butting ends of compression flanges and compression members, and of girders and other members which are to be spliced by riveted or bolted joints, shall be faced after fabrication so as to be in close contact throughout.

7.2 Welding, Supervision of Welding Flame Cutting Procedure Trials

When directed by the Engineer and before fabrication is commenced, welding and flame cutting procedure trials shall be carried out using representative samples of materials to be used in the Works.

The samples of materials shall be selected and marked by the Engineer when the materials for the work are inspected at the mills.

Trials on material 20 mm thick shall be taken to include all material up to but not exceeding 20 mm thick. Trials on material 40 mm thick shall be taken to include material over 20 mm and up to but not exceeding 40 mm thick. Materials over 40 mm thick shall be tested for every thickness increment of 6 ram.

The welding and flame cutting trials shall demonstrate to the satisfaction of the Engineer the procedures to be adopted in the fabrication of the work which shall include :-

(a) Welding procedure in accordance with BS 5135: 1984.

(b) The heat control techniques required to ensure that the flame cut surfaces of steel are free from cracks, local hardness, and any other defects which would be detrimental to the finished work.

The trials shall include specimen weld details representative of the actual construction which shall be welded in a manner simulating the most unfavourable conditions liable to occur in the particular fabrication. Where primers are to be applied to the work prior to fabrication, they shall be applied to the sample material before the procedure trials are made. After welding the specimens shall be held at a temperature not less than 50 degree Fahrenheit for a period not less than 72 hours and shall then be sectioned and examined for cracks and other defects.

The following groups of tests to BS 709: 1983 shall be carried out in accordance with Clause 7.7.

(a) Butt Welds :-
- Transverse tensile test.
- Transverse and longitudinal bend tests.
- Separate tests shall be performed in each case with the root of the weld in tension and compression respectively.
- Charpy V-notch impact tests except for Grades 43A and 50B steels to BS 4360 : 1986.
- Macro examination test.

(b) Fillet Welds :-
- Fillet weld fracture test.
- Macro examination test,

7.3 Qualification and Testing of Welders

Only skilled welders shall be employed and shall have previously undertaken selected tests as described in BS 4871.

7.4 Supervision of Welding

Welding shall be carried out only under the direction of an experienced and competent supervisor. Unless otherwise agreed by the Engineer, a record shall be kept to enable major butt welds to be identified with the welders responsible for the work but finished work shall not be marked by hard stamping for this purpose.

7.5 Welding Plant

Welding plant, instruments, cables and accessories shall comply with the requirements of the appropriate Parts of BS 638. The contractor shall be responsible for ensuring that the capacity of the welding plant and ancillary equipment is adequate for the welding procedure to be used and for maintaining all welding plant and ancillary equipment in good working order.

7.6 Welding Consumables

All welding consumables shall be stored and handled with care in accordance with the BS EN 499 : 1995 and manufacturer's recommendations. Electrodes, filler wires and rods and fluxes that show sign of damage or deterioration shall not be used.

7.7 Welding

Unless otherwise described in the Contract, metal-arc welding shall comply with BS 5135 : 1984 as appropriate except for tack welds and temporary attachments for which the procedures laid down in BS 5135 : 1984 shall be followed.

Electrodes and fluxes shall be used in accordance with the manufacturer's instructions. The use of welding processes other than those covered by BS 5135: 1984 shall be subject to the approval of the Engineer.

Unless otherwise approved by the Engineer, the welding consumables and procedures used shall be such that the yield and tensile strength of deposited weld metal shall not be less than the respective minimum values of the parent metal being welded.

The general welding programme for shop and site weld, including particulars of the preparation of fusion faces, the method of pre-heating and/or post-heating where approved by the Engineer, the methods of making the welds, the number of passes proposed for particular welds and the types of electrodes shall be submitted to the Engineer for his approval before the work is put in hand. No departure from the agreed welding programme or from the details shown on the Drawings shall be made without the agreement of the Engineer. Electrodes and fluxes shall be so chosen that the properties of the deposited metal are not inferior to those of the parent metal. Particular care over choice of welding technique shall be taken to minimise residual weld stresses and deformation of the steel due to welding.

The procedures for welding and flame cutting established by the procedure trials under Sub-clause 7.2 shall be strictly followed.

Unless otherwise described in the Contract, all butt welds shall be complete penetration welds made between prepared fusion faces.

In the fabrication of built-up assemblies, all butt welds in each component part shall be completed, whenever possible, before the final assembly.

The position of welds required for temporary attachments shall be agreed by the Engineer before the work commences.

Where automatic or semi-automatic processes are used, back gouging of the deposited weld will not be required where the Engineer is satisfied that the root run is free from imperfection.

Where butt welds are to be ground flush there shall be no loss of parent metal. The final grinding shall be in the direction described in the Contract.

In butt joints the root edges or root faces shall not be out of alignment by more than one eighth of the thickness of the thinner material for material up to 12 mm thick or by more than 1.5 mm for thicker material.

Requirements for 'run-on' plates and 'run-off' plates shall be as follows :-

(a) One pair of run-on plates and one pair of run-off plates all prepared to the same thickness and profile as the parent metal shall be attached by clamps to the start and finish respectively of all butt welds. Unless otherwise required by the Engineer, approximately 1 in 5 pairs of run-off plates for butt welds in tension flanges and 1 in 10 pairs for other butt welds shall be production test plates. The combined size of each pair of production test plates shall be either 230 mm, 300 mm or 380 mm wide x 200 mm long, as shown in Table 13.2, the length being measured in the rolling direction of the metal and at right angles to the weld.

TABLE 2 - SIZES OF RUN-OFF PRODUCTION TEST PLATES

Combined Size (Per Pair) of Run-Off Production Test Plates			
	Plates Up to 30 mm Thick	Plates from 30 mm to 75 mm Thick	Plate Over to 75 mm Thick
Steel of Grades 43A and 50B to BS 4360 : 1986	230 x 200	300 x 200	Sizes to be agreed with the Engineer
Steel of Grades 40C, D and E, 43C, D and E and 50C to BS 4360 : 1986	300 x 200	380 x 200	

(b) Butt welds shall run the full length of the joint and extend at full weld profile for a

minimum distance of 200mm x 275mm and 250mm respectively into the 230mm x 300mm, 300mm x 200mm and 380mm x 200mm run-off production test plates.

(c) On completion of the welds the run-off production test plates shall not be removed until they have been marked in a manner agreed by the Engineer to identify them with the joints to which they are attached.

(d) When removing the run-on and run-off plates by flame cutting, the cuts shall not be nearer than 6 mm to the sides of the parent metal and the remaining metal shall be removed by grinding or other method agreed by the Engineer.

(e) Specimens for the following tests to be carried out in accordance with Sub-Clause 7.7 shall be selected from the run-off production test plates by the Engineer :-

(i) Transverse tensile test(s). (The number of test piece shall be sufficient to cover the full thickness of plate).
(ii) Transverse bend test.
(iii) Three Charpy V-notch tests except for steel of Grades 43A and 50B to BS 4360 : 1986.

7.8 Testing of Welding

The tests detailed in Sub-Clauses 7.2 and 7.6 shall be carried out by the methods described in BS 709 : 1983. The following requirements shall also be met :-

(a) The test results of welded joints shall not be inferior in any respect to the British Standard test requirements for the parent metal.

(b) Procedure Trials (Sub-Clause 7.2)

(i) Tensile and Bend Tests : Should any one of the weld joint test pieces selected for transverse tensile and transverse and longitudinal bend tests fail to comply with the test requirements applicable to the parent metal of the joint represented by the test, 2 additional test pieces shall be taken from the joint material represented by the test. Both shall then comply with the test requirements in order to qualify for acceptance.

(ii) Charpy V-notch Tests: Should the average impact value obtained from any set of 3 Charpy V-notch specimens fail to comply with the test requirements, 3 additional test pieces from the same sample shall be tested. The average of the 6 test results shall comply with the test requirements in order to qualify for acceptance.

(iii) Revised Procedures: In the event of failure to meet the test requirements, the Contractor shall carry out further trials using revised procedures and further tests to the satisfaction of the Engineer.

(c) Production Tests (Sub-Clause 7.6)

(i) Production Test Plates: The run-off production test plate sizes specified shall be cut on the instructions of the Engineer in order to enable up to 2 complete sets of test specimens to be obtained.

(ii) Tensile and Bend Tests : Should any one of the weld joint test pieces selected for transverse tensile and transverse bend tests fail to comply with the test requirements applicable to the parent metal of the joint represented by the test, additional specimens shall be cut from the same production test plates and the tests repeated. Should either of the additional tests fail to comply with the

requirements, the joint shall be rejected.

(iii) Charpy V-notch Tests: Should the average impact value obtained from any set of 3 Charpy v-notch specimens selected fail to comply with the test requirements, 3 additional test pieces from the same production test plates shall be tested.

Should the average of the 6 test results fail to comply with the test requirements, the joint shall be rejected.

(iv) Re-welding and Re-testing : In the event of failure to meet the test requirements the welded joint represented by the tests shall be completely cut out. The joint shall then be rewelded and the tests repeated.

(d) Non-Destructive Testing

A method of non-destructive testing agreed with the Engineer shall be used for the examination of butt welds in tension members and where otherwise directed by the Engineer.

(e) Radiographic Inspection of Welding

As a further control of weld quality, the Contractor will be requested to submit for approval radiographs of weld selected by a competent inspector to be approved by the Engineer. The length of weld to be radiographed at any one location shall be determined by the Engineer.

Where radiographic inspection reveals defects in the welds, the welds shall be re-welded or the Contractor shall be permitted to carry out repairs and these shall be required to pass the radiographic inspection at the Contractor's expense.

8.0 HANDLING AND TRANSPORTATION TO SITE

8.1 Handling

Fabrication parts shall be handled and stacked in such a way that permanent damage is not caused to the components. Means shall be provided to minimise damage to the protective treatment on the steelwork and any damage which does occur shall be made good,

8.2 Transportation to Site

All works shall be protected from damage in transit. Particular care shall be taken to stiffen free ends and prevent permanent distortion and adequately protect all galvanized surfaces. All bolts, nuts, washers, screws, small plates and small articles generally shall be suitably packed and identified.

9.0 ERECTION

Erection procedure shall be in accordance with proposals submitted by the Contractor and approved by the Engineer, and no divergence from the approved procedure will be permitted except if agreed to in writing by the Engineer.

The Contractor shall inform the Engineer when fabricated sections are ready for inspection prior to erection. No erection shall then be permitted until the Engineer approves the fabrication.

During erection care shall be taken to avoid any shock, dynamic or vibrationary loading of the members.

No members in the Works shall be finally bolted, welded or otherwise joined until the whole of a major section is approved by the Engineer. Connection shall be made as soon as possible after the Engineer's written approval is received. Care shall be exercised to avoid interference with members already in place.

10.0 HOLES FOR BOLTS

All holes shall be accurately marked off from templates or corresponding plates, and drilled, except in plates 10 mm thick or under, when they may be punched. Holes should be cleaned or burrs or rough edges and counter-sunk where required. No drifting shall be allowed. Holes for high strength friction grip bolts shall comply with the requirement of BS 4604.

11.0 HOLDING DOWN BOLTS

The Contractor shall supply and position holding down bolts as detailed in the drawings including nuts, washers m.s. angles, etc. They shall be fixed accurately and rigidly to the lines and levels as shown in the drawings. It is absolutely necessary to ensure that the bolts are not disturbed once positioned and care shall be taken to ensure that the bolts are not displaced during concreting.

12.0 HIGH STRENGTH FRICTION GRIP BOLTS

12.1 Bolt System

High strength friction grip bolts (H.S.F.G. bolts) to BS 4395 General Grade, Part 1 shall be used in conjunction with an approved Load Indicating Washer (L.I. Washer). The term "H.S.F.G. bolts" in these Specifications shall be deemed to include a H.T. bolt, a H.T. nut, a L.I. washer and one or two H.T. flat or taper washers as appropriate. The LI. washer shall be additional to the normal washer employed and not take the place of a normal flat or taper washer.

12.2 Design Procedure

The design procedure of General Grade H.S.F.G. bolts shall comply with BS 4604, except where this Standard conflicts with the recommendations of the manufacturer of the L.I. washer in respect of tightening H.S.F.G. bolts, when the manufacturer's recommendation shall take precedence but subject to the approval of the Engineer. The Contractor's erection drawings shall clearly indicate the correct size and length of bolt to be fitted.

The H.S.F.G. bolt system shown on the Drawings may be replaced by other system so long as the Contractor submit detailed calculations complying with the requirements of BS 4395 : Part 1 and BS 4604.

12.3 Material

The bolts, nuts and washers shall comply with the requirements of BS 4395, Part 1.

All bolts, nuts, plates, etc when specified shall be hot-dip galvanised.

Materials to be galvanised shall be thoroughly cleaned of all scale, dust and dirt by pickling in a bath of muriative acid. They shall then be dipped in a bath of molten virgin spelter containing not more than 2.5% impurities and shall remain in the bath until all surfaces are evenly coated with

firmly adherent spelter and the additional weight must not be less than 2.76 Kg. per square metre.

12.4 Storage

The bolts, nuts and washers shall be stored in a proper dry shed and be adequately protected from inclement weather or contamination so that they will not deteriorate. The bolts are normally supplied by the manufacturers with sufficient residue oil on the threads of the bolt and nut which is not detrimental and should not removed. In this condition they are ready for normal use, and any further treatment at work shop or site is not recommended. If the threads, nuts and washers are dry, rusty or dirty, they must be cleaned and re-lubricated to reduce thread friction during bolt tightening.

12.5 Bolt Assembly

Where plane parallel surfaces are involved each H.S.F.G. bolt shall be assembled with a flat round H.T. washer and a Load Indicating washer under the bolt head or nut whichever is to be rotated during tightening. The rotated bolt head or nut shall always be tightened against a surface normal to the bolt axis.

Where the surfaces are not parallel, tapered H.T. washer are used. Such a washer shall also be used under the non-rotated component except where the angle between bolt axis and contact surface is within 90 degrees centigrade ±3 degree. Tapered H.T. washers shall be correctly positioned.

Generally, the Load Indicating washer is placed under the bolt head with the protrusions bearing against the bolt when the nut is turned during tightening.

If the bolt head is to be turned instead of the nut, then the Load Indicating washer shall be placed at the nut end of the bolt assembly with the protrusions bearing against a nut face H.T. washer between the Load Indicator and the nut. Movement of the washer is acceptable during tightening of the bolt but the gap should, however, be reduced to 0.25 mm for General Grade part 1 and 0.35 mm for Higher Grade Part 2 bolts. Nuts shall be placed in such a manner that their identification marks are clearly visible after tightening.
No gasket or other flexible material shall be placed between the steel work. The holes shall be sufficiently well aligned to permit bolts to be freely inserted in position. The bolts shall not be forced in position, i.e. driving of bolts is not permitted.

12.6 Tightening Procedure

It is important that all bolts and nuts shall be tightened to the minimum shank tensions as specified by the Manufacturer and to the approval of the Engineer.

When tightening a group of bolts in a joint, there may be an incremental loss of tension in the first ones when adjacent bolts in the same group are being tightened due to the flexure of the steel members. As such, the bolt may have to be retightened a second time or more to the satisfaction of the Engineer that the required tension has been achieved.

Bolts and nuts shall always be tightened from the centre of the joint outward when tightening a group of bolts. This will help to minimise unwanted gap or loss of tension at the contact surface at the end of the joint splice if the bolts are tightened progressively from one end to the other. Retightening of the bolts shall be done as directed by the Engineer until he is satisfied that the required shank tension has been achieved.

If after final tightening a bolt or nut is slackened off for any reason, the bolt, nut, Load Indicator and washer or washers shall be condemned and discarded.

The condemned bolt, nut load indicator and washer or washers shall be removed from site and not reused.

12.7 Tightening

Tightening of the bolts and control of bolt tension shall be of the "Coronet" Load Indicator method. The Load Indicator is a specially hardened washer with protrusions of one face which bear against the underside of the bolt head leaving a gap or bearing against a nut face H.T. washer between the Load Indicator and the nut is placed at the nut end of the bolt assembly.

As the bolt is tightened the protrusions are flattened and the gap reduced until an average gap of 0.40 mm or less is achieved when placed under a head fitting. When the Load Indicator is used with a nut face washer, the gap should be reduced to 0.25 mm for General Grade Part 1 and 0.25 mm for Higher Grade Part 2 bolts. Under no circumstances shall hammer be used to flatten the protrusions of the L.T. washer in order to achieve the minimum required gap.

It is necessary to ensure that the average gap between the Load Indicator and the bolt head or nut face washer has been reached and this can easily be checked with a feeler gauge.

The minimum shank tension of General Grade Part 1 and Higher Grade Part 2 H.S.F.G. bolts are given in Table 2, BS 4604 : 1970.

APPENDIX TO STRUCTURAL STEEL SPECIFICATIONS
List of British Standards Use in Structural Steel

BS 4 :	Structural Steel Sections
BS 449 :	Use of Structural Steel in Buildings
BS 638 :	Arc Welding Power Sources, Equipment and Accessories
BS 709 : 1983	Fusion Welded Joints and Weld Metal in Steel
BS 729 : 1971	Hot Dip Galvanised Coatings on Iron and Steel Articles
BS 916 : 1953	Black Bolts, Screws and Nuts
BS 1391 : 1952	Protective Schemes used in the Protection of Light Gauge Steel and Wrought Iron against corrosion
BS 1449 :	Steel Plate, Sheet and Strip
BS 1453 : 1972	Filler Materials for Gas Welding
BS 1494 :	Fixing Accessories for Building Purposes
BS 2600 :	Radiographic Examination of Fusing Welded Butt Joints in Steel
BS 2630 : 1982	Projection of Welding of Low Carbon Steel Sheet and Strip
BS 2994 : 1976	Cold Rolled Steel Sections
BS 3410 : 1961	Metal Washers for General Engineering Purposes
BS 3571 :	General Recommendations for Manual Inert-gas Metal-arc Welding
BS 3923 :	Ultrasonic Examination of Welds
BS 4215 :	Spot Welding Electrodes and Electrode Holders
BS 4360 : 1986	Weldable Structural Steels
BS 4395 :	High Strength Friction Grip Bolts And Associated Nuts and Washers for Structural Engineering
BS 4604 :	The Use of High Strength Friction Grip Bolts in Structural Steelwork
BS 4848 :	Hot Rolled Structural Steel Sections
BS 4870 :	Approval Testing of Welding Procedures
BS 4871 :	Approval Testing of Welders Working To Approved Welding Procedure
BS 4872 :	Approval Testing of Welders When Welding Procedure Approval Is Not Required
BS 5135 : 1984	Metal-arc Welding of Carbon and Carbon Manganese Steels
BS 5289 : 1976	Visual Inspection of Fusion Welded Joints
BS 5950 :	Structural Use of Steelwork In Building
BS 7079 : 1989	Preparation of Steel Substrates Before Application of Paint and Related Products
BS 7613 : 1994	Hot Rolled Quenched and Tampered Weldable Structural Steel Plates
BS 7668 : 1994	Specification for Weldable Structural Steel: Hot Finished Structural Hollow Sections In Weather Resistant Steel
BS EN 499 : 1995	Welding Consumables. Covered Electrodes for Manual Metal Arc Welding of Non Alloy and Fine Grain Steel. Classification
BS EN 10029 : 1991	Specification For Tolerances on Dimensions, Shape and Mass for Hot Rolled Steel Plates 3mm Thick or Above
BS EN 10113 : 1993	Parts 1 to 3. Hot Rolled Products In Weldable Fine Grain Structural Steel
BS EN 10155 : 1993	Structural Steel With Improved Atmospheric Corrosion Resistance. Technical Delivery Conditions

SWEDISH STANDARD SIS 055900-1967 - Pictorial surface preparation standards for painting steel surfaces.

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